VASCULAR UNDERSTORY PLANT COMPOSITION IN A MICROTOPOGRAPHIC SETTING, ATCHAFALAYA BASIN, LOUISIANA

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ABSTRACT

Understory plant frequencies were recorded in a microtopographic setting in the Atchafalaya Basin, Louisiana during summer 1993 and summer 1994. Microtopography on the study area greatly influences duration of inundation. Habitat preferences of many herbs and woody seedlings to either bottomland hardwood ridges or slightly lower baldcypress-tupelogum swales were apparent. Other species were generalists and occurred commonly in both habitat types. Of the 87 taxa recorded, mostly at the species level, 49 showed affinities to bottomland hardwood ridges and 9 to baldcypress-tupelogum swales.

KEYWORDS: Atchafalaya Basin, Louisiana, plant frequencies

INTRODUCTION AND STUDY AREA

Understory plants were recorded in the Atchafalaya Basin, Louisiana during the summers of 1993 and 1994 as a component of studies aimed to assess wildlife habitat following Hurricane Andrew, which impacted the area in August, 1992. Studies on plant distribution relative to elevation in bottomland forests of the southeastern U.S. have focused primarily on woody plants. Data presented here details herbaceous plant and woody seedling abundance and could be useful in planning projects that aim to restore bottomland hardwood and baldcypress-tupelogum forests in interspersed, microtopographic settings and could perhaps be useful in refining regional wetland indicator statuses of plants.

The study area is located south of Interstate 10 between the Atchafalaya and Mississippi Rivers in Iberville Parish, Louisiana. Thirty-three study plots were located approximately 10 km south of Ramah in sections 59 and 61 (T8S-R10E). Fifteen plots were located approximately 10 km west of Plaquemine and 15 km east of the above-mentioned plots in section 9 (T9S-R11E).

The study area occurs at elevations less than 3.0 m mean sea level (msl) (U.S.D.I. Geol. Surv. 1953a and 1953b) within a very gentle ridge-swale complex that results in an interspersion of two forest types: Bottomland hardwood forests occupying slightly elevated areas (hereafter referred to as "ridges") with an overstory comprised mainly of *Acer negundo*, *Acer rubrum*, *Celtis laevigata*, *Fraxinus pennsylvanica*, *Liquidambar styraciflua,* and *Ulmus americana*; and baldcypress-tupelogum forests (hereafter referred to as "swales") occupying slightly lower areas comprised of *Taxodium distichum* and *Nyssa aquatica*, but also supporting *Acer rubrum*, *Celtis laevigata* and *Fraxinus pennsylvanica*.

In addition to the presence of two forest types, the study area was characterized by pulpwood [less than 25 cm diameter at breast height (dbh)] and sawtimber (greater than 25 cm dbh) sized trees and different degrees of hurricane damage (see Helm 1995; Salyer 1995). Understory plant frequencies with respect to every combination of forest type, tree size, and degree of hurricane damage for each sampling period are appended in Helm (1995), but the present paper will address microtopographic effects as indicated by forest type.

Small elevational differences greatly impact durations of flooding within the study area. Water typically inundates swales from late winter through early summer, while ridges typically support some standing water during this time period, primarily after heavy rainfall. Ridge plots were typically dry during understory vegetation sampling in the summers of 1993 and 1994 while many swale plots supported some shallow standing water. Non-inundated areas of swale plots during summer typically supported saturated soils to the surface. Rain is the primary source of water in the study area but water influx from flooding of nearby bayous occasionally occurs. Deep water baldcypress-tupelogum swamps are characterized by standing water throughout the growing season (Huenneke and Sharitz 1986). Swales in the study area can be considered shallow water baldcypress-tupelogum swamps and provide opportunity for germination of a diversity of species during the summer because of the general availability of non-inundated ground.

Sharkey clay and Fausse association soils have been mapped on the study area (U.S.D.A. Soil Conserv. Serv. 1977). They formed in clayey alluvium during the Holocene and are considered hydric soils (U.S.D.A. Soil Conserv. Serv. 1995). The Sharkey series (very fine, montmorillonitic, nonacid, thermic, Vertic Haplaquepts) consists of poorly drained, very slowly permeable soils on slopes of 0-3% and occurs at elevations from 1.5-6.1 m msl on low and intermediate parts of natural levees of the Mississippi River and its distributaries. The Fausse series (very fine, montmorillonitic, nonacid, thermic, Typic Fluvaquents) consists of very poorly drained, very slowly permeable soils on slopes less than 0.5% and occurs at elevations less than 3.0 m msl in backswamps (U.S.D.A. Soil Conserv. Serv. 1977). On the study area, Sharkey soils are more typical of ridges and Fausse soils of swales.

METHODS

It became apparent when in the field and upon analysis of plant frequencies data, that many taxa showed marked differences in abundance with respect to forest type but not with respect to tree size or degree of hurricane damage and, therefore, understory plant frequency would be best presented with respect to forest type. Effects of light penetration, however, are discussed briefly below. Also, records of plants recorded during winter are noted below.

Study plots were established during summer 1993. Data were recorded within 1 m^2 quadrats during summer 1993 and summer 1994. Quadrats resulted from division of 4 m^2 subplots. Four subplots were randomly located within each of 48, 0.1 ha plots resulting in 768 quadrats. Equal numbers of plots were established on ridges and in swales.

Understory vegetation included plants that were no taller than 1 m. Presence of understory plants was recorded by taxon in each quadrat. Plants were required to be rooted in a quadrat to be considered present. Within each forest type, frequency was calculated for each plant taxon; frequency equal to the percent of quadrats in which at least one plant of a given taxon occurred.

Paired t-tests were used to detect differences in plant taxon frequencies, mostly at the species level, on ridges versus swales for summer 1993 and summer 1994 combined. Alpha=0.05 was the significance level chosen for each taxon-based test.

RESULTS AND DISCUSSION

Differences in understory plant frequencies on the study area are believed to have resulted primarily from species-specific sensitivity to varying degrees of wetness with respect to abilities of plants to germinate and grow. Flood frequency and duration (hydroperiod) are the primary factors influencing woody plant distribution in bottomland forests of the southeastern U.S. (Grell et al. 2005; Wall and Darwin 1999). Of the 87 taxa recorded during summers 1993 and 1994, 49 showed affinities to ridges and 9 to swales. Extremely low p-values ($\leq$ 0.01) were associated with many of the taxa, both herbs and woody seedlings, indicating strong habitat affinities (Table 1).

Woody seedlings with strong affinities to ridges included *Acer negundo*, *Cornus drummondii*, *Forestiera acuminata*, *Ilex decidua*, *Liquidambar styraciflua*, *Planera aquatica*, *Sabal minor*, and *Sambucus canadensis*. Only *Acer rubrum* showed a strong affinity to swales. *Celtis laevigata*, *Fraxinus pennsylvanica*, and *Ulmus americana* seedlings were common in both ridge and swale habitats (frequencies per $m^2 \geq 5\%$ in each habitat type) and could be considered generalists with respect to elevation at the seedling stage. Among woody vines, *Berchemia scandens* was common in both habitats. Although not identified to species level, *Rubus* spp. was abundant and showed a strong affinity to ridges.

Species with strong affinities to ridges included *Asplenium platyneuron*, *Campsis radicans*, *Cocculus carolinus*, *Duchesnea indica*, *Elephantopus tomentosus*, *Eupatorium semiserratum*, *Hydrocotyle umbellata*, *Lonicera japonica*, *Melothria pendula*, *Oplismenus setarius*, *Parthenocissus quinquefolia*, *Perilla frutescens*, *Polygonum virginianum*, *Sanicula canadensis*, *Thelypteris palustris*, and *Vitis rotundifolia*. Conversely, *Eclipta prostrata*, *Phanopyrum gymnocarpon*, *Pluchea foetida*, *Rhynchospora corniculata*, and *Senecio glabellus* showed strong affinities to swales. *Ampelopsis arborea*, *Boehmeria cylindrica*, *Brunnichia ovata*, *Justicia ovata*, and *Vitis aestivalis* were common in both habitats. Many of the taxa, both woody and herbaceous, that showed no habitat affinity occurred in low frequencies. In these cases, habitat affinities may be obscured by the statistical inability to demonstrate differences in frequencies between habitat types because of sample size limited by inherent plant abundance.

The dominant overstory species in swales, *Taxodium distichum* and *Nyssa aquatica*, were sparsely represented as seedlings. Conversely, dominant overstory species on ridges (*Acer negundo*, *Acer rubrum*, *Celtis laevigata*, *Fraxinus pennsylvanica*, and *Ulmus americana*) were well represented as seedlings on ridges. *Acer rubrum*, *Celtis laevigata*, and *Fraxinus pennsylvanica*, all represented in the overstory in swales but to a lesser degree than *Taxodium distichum* and *Nyssa aquatica*, were common as seedlings in swales. *Taxodium distichum* can germinate and develop under partial shade while *Nyssa aquatica* is shade intolerant. Neither can germinate under inundated conditions and both can be adversely affected in the seedling stage by prolonged flooding (Burns and Honkala 1990). Also, various microsite characteristics can influence seedling abundance of both species (Huenneke and Sharitz 1986). As seedlings of less water tolerant species were numerous even in swale plots, prolonged flooding was not thought to have adversely affected seedling establishment of *Taxodium distichum* and *Nyssa aquatica*. Low seedling abundance of *Nyssa aquatica* may be related to the generally dense forest canopy (see discussion below on light penetration and understory plant abundance). Factors resulting in the paucity of *Taxodium distichum* seedlings are not clear.

NOTES ON LIGHT PENETRATION AND UNDERSTORY PLANT ABUNDANCE

As noted above, the study was conducted in areas of pulpwood (high value timber was harvested during the 1960's) and sawtimber sized trees and varying degrees of damage from Hurricane Andrew. Although this paper focuses on microtopographic influences on plant abundance, overstory canopy cover, an indicator of light penetration, is another potentially important factor affecting plant occurrence (Menges and Waller 1983) and will be summarized here. For a more detailed discussion on overstory-understory relationships on the study area, see Helm (1995) and Helm and Chabreck (2004). Overstory canopy cover was measured on the study plots using a spherical densitometer (Lemmon 1956) held at a height of 1 m and showed no differences in plots characterized by pulpwood versus sawtimber sized trees or ridges versus swales but was dependent on degree of hurricane damage. Differences in understory plant frequencies with respect to degree of hurricane damage, however, emerged only several times when analyzing data, and could be statistical artifacts of the large number of taxa studied. While degree of hurricane damage dictated amount of overstory canopy cover, amount of light penetration to the forest floor may not have been related to hurricane damage one year after the hurricane during summer 1993 because of leaf production on downed trees that provided shade but were not entirely accounted for in readings of overstory canopy cover. Tree death and resultant leaf loss two years after the hurricane in summer 1994, however, was thought to have resulted in differences in light penetration to the forest floor with respect to degree of hurricane damage and affected understory cover, understory cover being greater in heavily damaged plots than in moderately and lightly damaged plots. Differences in light penetration during summer 1994, however, although difficult to absolutely quantify, were apparently not great enough to produce taxon-specific differences in understory plant frequencies.

NOTES ON PLANTS RECORDED DURING WINTER

Understory plants were also recorded on the study plots during January 1995 and are appended in Helm (1995). During winter 1995 sampling, swale plots supported varying depths of standing water (hip waders were often required) while ridge plots often had some shallow standing water. Many herbs were in the seedling stage at time of sampling. Taxa recorded during winter that were not recorded during either of the summer sampling periods are noted below in order to provide a more complete botanical account of the study area: *Andropogon* spp., *Cardamine pensylvanica* Muhl. *ex* Willd., *Carex* spp., *Chaerophyllum tainturieri* Hook., *Cirsium horridulum* Michx., *Commelina* sp., *Cyperus articulatus* L., *Erigeron philadephicus* L., *Galium aparine* L., *Geranium carolinianum* L., *Geum canadense* Jacq., *Gnaphalium* spp., *Ilex vomitoria* Ait., *Lobelia cardinalis* L., *Nemophila aphylla* (L.) Brummitt, *Physalis heterophylla* Nees, *Pleopeltis polypodioides* (L.) Andrews & Windham, *Quercus laurifolia* Michx., *Quercus phellos* L., *Quercus virginiana* P. Mill., *Spiranthes ovalis* Lindl., *Stellaria media* (L.) Vill., and *Urtica chamaedryoides* Pursh.

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LITERATURE CITED

Burns, R.M and B.H. Honkala (Tech. Coords.). 1990. Silvics of North America. Agric. Handbook No. 654. U.S.D.A. For. Serv., Washington, DC. Vol. 1 (Conifers). 681 pp. and Vol. 2 (Hardwoods). 877 pp.

Grell, A.G., M.G. Shelton, and E. Heitzman. 2005. Changes in plant species composition along an elevation gradient in an old-growth bottomland hardwood-*Pinus taeda* forest in southern Arkansas. J. Torrey Bot. Soc. 132:72-89.

Helm, S.R. 1995. Assessment of swamp rabbit habitat in Louisiana forested wetlands impacted by Hurricane Andrew. M.S. Thesis, Louisiana State Univ., Baton Rouge, Louisiana. 75 pp.

.... and R.H. Chabreck. 2004. Response of understory plant cover to Hurricane Andrew damage in the Atchafalya Basin, Louisiana. Proc. Louisiana Acad. Sci. 65:17-21.

Huenneke, L.F. and R.R. Sharitz. 1986. Microsite abundance and distribution of woody seedlings in a South Carolina cypress-tupelo swamp. Amer. Midl. Natur. 115:328-335.

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Second ed. Timber Press, Portland, Oregon. Vol. 1. 622 pp. and Vol. 2. 816 pp.

Lemmon, P.E. 1956. A spherical densitometer for estimating forest overstory density. For. Sci. 2:314-320.

Menges, E.S. and D.M. Waller. 1983. Plant strategies in relation to elevation and light in floodplain herbs. Amer. Natur. 122:454-473.

Salyer, M.R. 1995. Assessment of Hurricane Andrew damage to white-tailed deer habitat in forested wetlands in Louisiana. M.S. Thesis, Louisiana State Univ., Baton Rouge, Louisiana. 58 pp.

U.S.D.A. Soil Conserv. Serv. 1977. Soil survey of Iberville Parish, Louisiana. Washington, DC.

U.S.D.A. Soil Conserv. Serv. 1995. Soil mapping units and hydric soils designations, Louisiana. Washington, DC.

U.S.D.I. Geol. Surv. 1953a (photorev. 1980). Addis, Louisiana quadrangle. 7.5 min. series.

U.S.D.I. Geol. Surv. 1953b (photorev. 1980). Grosse Tete SW, Louisiana quadrangle. 7.5 min. series.

Wall, D.P. and S.P. Darwin. 1999. Vegetation and elevation gradients within a bottomland hardwood forest of southeastern Louisiana. Amer. Midl. Natur. 142:17-30.

Table 1. Mean understory plant frequency per m^2 for summers 1993 and 1994 (combined), differences in frequencies between forest types (bottomland hardwood ridges and baldcypress-tupelogum swales) (reported for P≤0.05), and habitat affinities in the Atchafalaya Basin, Louisiana. [1]Scientific names in accord with Kartesz (1994).

Scientific Name and Author[1]	Frequency Ridge	Frequency Swale	p-value	Habitat
Acer negundo L.	22.4	9.9	$5x10^{-5}$	Ridge
Acer rubrum L.	14.7	24.3	0.004	Swale
Acmella oppositifolia (Lam.) R.K. Jansen	0.3	0.7		
Ampelopsis arborea (L.) Koehne	27.3	23.6		
Ampelopsis cordata Michx.	4.0	9.1	0.04	Swale
Asimina triloba (L.) Dunal	2.2	0.0	0.05	Ridge
Asplenium platyneuron (L.) B.S.P.	2.5	0.0	0.01	Ridge
Aster spp. L.	2.3	0.5		
Berchemia scandens (Hill) K. Koch	12.9	14.0		
Boehmeria cylindrica (L.) Sw.	55.2	54.8		
Brunnichia ovata (Walt.) Shinners	9.2	6.9		
Campsis radicans (L.) Seem. *ex* Bureau	12.0	3.0	0.005	Ridge
Carya aquatica (Michx. f.) Nutt.	0.0	0.5		
Celtis laevigata Willd.	23.2	26.8		
Cephalanthus occidentalis L.	0.3	0.0		
Ciclospermum leptophyllum (Pers.) Sprague	1.0	0.1	0.05	Ridge
Cirsium spp. P. Mill.	6.3	0.4	$4x10^{-5}$	Ridge
Cocculus carolinus (L.) DC.	3.5	0.3	0.004	Ridge
Cornus drummondii C.A. Mey.	9.2	1.7	$6x10^{-5}$	Ridge
Crataegus spp. L.	0.5	0.0	0.05	Ridge
Cynodon dactylon (L.) Pers.	3.1	0.4	0.03	Ridge
Cyperaceae	16.0	41.7	$2x10^{-5}$	Swale
Desmodium spp. Desv.	0.8	0.1	0.05	Ridge
Dichondra carolinensis Michx.	1.3	0.1	0.02	Ridge
Diodia virginiana L.	0.5	2.0		
Diospyros virginiana L.	1.2	0.4		
Duchesnea indica (Andr.) Focke	10.6	1.0	$7x10^{-5}$	Ridge
Eclipta prostrata (L.) L.	0.8	8.3	0.002	Swale
Elephantopus tomentosus L.	5.6	0.1	$3x10^{-5}$	Ridge
Eupatorium semiserratum DC.	30.3	5.0	$9x10^{-6}$	Ridge
Forestiera acuminata (Michx.) Poir.	1.8	0.0	0.009	Ridge
Fraxinus pennsylvanica Marsh.	16.4	11.6		
Gleditsia triacanthos L.	0.3	0.3		
Hamamelis virginiana L.	0.0	2.2		
Heliotropium spp. L.	0.0	0.9		
Hydrocotyle umbellata L.	16.9	6.0	0.0005	Ridge
Hypericum spp. L.	0.1	0.5		
Ilex decidua Walt.	3.5	1.2	0.01	Ridge
Ilex opaca Ait.	0.1	0.0		
Justicia ovata (Walt.) Lindau	9.0	10.9		
Leersia oryzoides (L.) Sw.	2.0	0.9		

Liquidambar styraciflua L.	4.7	0.7	0.002	Ridge
Lonicera japonica Thunb.	11.7	0.0	0.0004	Ridge
Ludwigia spp. L.	6.4	3.4		
Lythrum spp. L.	8.9	13.4		
Melothria pendula L.	17.3	1.1	$1x10^{-6}$	Ridge
Mikania scandens (L.) Willd.	3.8	6.8		
Nyssa aguatica L.	0.3	0.0		
Oplismenus setarius (Lam.) Roemer & J.A. Schultes	52.2	4.4	$5x10^{-13}$	Ridge
Oxalis spp. L.	1.8	0.0	0.01	Ridge
Panicum spp. L.	8.5	1.8	0.03	Ridge
Parthenocissus quinquefolia (L.) Planch.	47.3	9.9	$7x10^{-8}$	Ridge
Perilla frutescens (L.) Britt.	4.3	0.0	0.01	Ridge
Phanopyrum gymnocarpon (Ell.) Nash	1.6	11.3	0.001	Swale
Phyla lanceolata (Michx.) Greene	0.0	0.1		
Phytolacca americana L.	0.3	0.0		
Planera aquatica J.F. Gmel.	7.8	1.3	0.01	Ridge
Plantago spp. L.	0.0	0.1		
Platanus occidentalis L.	0.0	0.3		
Pluchea foetida (L.) DC.	0.8	17.5	$2x10^{-6}$	Swale
Poaceae	10.4	2.7	0.005	Ridge
Polygonum spp. L.	20.0	17.7		
Polygonum virginianum L.	26.0	3.3	$1x10^{-7}$	Ridge
Quercus spp. L.	4.0	1.2	0.002	Ridge
Rhynchospora corniculata (Lam.) Gray	0.1	7.0	$4x10^{-5}$	Swale
Rubus spp. L.	67.2	16.4	$3x10^{-13}$	Ridge
Sabal minor (Jacq.) Pers.	1.6	0.0	0.004	Ridge
Sambucus canadensis L.	4.8	0.5	0.004	Ridge
Samolus valerandi L.	0.1	0.7		
Sanicula canadensis L.	23 7	1.7	$5x10^{-8}$	Ridge
Saururus cernuus L.	16.2	25.6	0.03	Swale
Senecio glabellus Poir.	3.9	21.5	0.0005	Swale
Sisyrinchium albidum Raf.	0.0	0.7		
Smilax spp. L.	9.8	2.7	0.0003	Ridge
Solanum carolinense L.	0.3	0.5		
Solidago spp. L.	2.3	0.3	0.02	Ridge
Sonchus oleraceus L.	0.0	0.1		
Taxodium distichum (L.) L.C. Rich.	0.0	0.7		
Thelypteris palustris Schott	16.9	1.4	$5x10^{-8}$	Ridge
Toxicodendron radicans (L.) Kuntze	60.0	46.3	0.01	Ridge
Trachelospermum difforme (Walt.) Gray	0.1	0.5		
Tradescantia ohiensis Raf.	1.3	1.2		
Ulmus americana L.	17.4	9.5		
Vicia spp. L.	0.5	0.0		
Viola spp. L.	20.3	2.4	$4x10^{-9}$	Ridge
Vitis aestivalis Michx.	8.9	9.8		
Vitis rotundifolia Michx.	5.3	0.8	0.01	Ridge